REMARKS/ARGUMENTS

1. Claims

Claims 1-5 & 8 -12 remain in this application. Claim 1 has been amended by incorporation of claim 7. Claim 7 has been cancelled herein. Claim 6 was previously cancelled. Claims 10-12 were previously withdrawn as a result of an earlier restriction requirement with applicants retaining the right to these claims in a divisional application.

2. §112 Rejection

Claim 1 was rejected under 35 U.S.C. 12, second paragraph as being indefinite. The claim recites "a cooling rate of 3 °C or less". Applicants have amended claim 1 to recite --a cooling rate of 3°C/hour or less--. Support for the amendment can be found in the Specification in Paragraph [0021] and also in original claim 6.

Applicants submit that the foregoing amendment overcomes the §112 Rejection and that it is now proper for the Examiner to withdraw this rejection.

3. § 103 Rejections

General comment regarding Sakuma

Applicants traverse the use of Sakuma as cited art and respectfully submit that should be withdrawn because it does not teach crystal growth. *Sakuma teaches only annealing* using a crystal that is grown in a separate, isolated procedure. Applicants submit that the application of Sakuma to the present invention is impermissible because it fails to account for the critical time during crystal growth in which "defects" are formed in a crystal. Applicants believe that the use of the times, temperatures and other conditions of Sakuma is impermissible, *out-of-context* "picking and choosing" of elements to show obviousness. Therefore, applicants respectfully submit that Sakuma should be withdrawn.

However, even though applicants believe that the citation of Sakuma is improper, applicants will nonetheless comment on Sakuma for completeness, showing that when combined with the other cited art it does not render the claimed invention obvious.

A. **Rejection over Herve in view or Obara or Sakuma**

The Examiner has rejected claims 1 – 5 and 7 – 9 under 35 U.S.C. § 103(a) as being unpatentable for obviousness over Herve et al (hereafter "Herve", WO 01/73168 A1) in view of Obara et al (hereafter "Obara", WO 02/077676, where US 6,850,371 is used as an accurate translation) or Sakuma, et al (hereafter "Sakuma", US 2002/0038625 A1). Applicants traverse the rejection.

Summary of the Rejection

Referring to claims 1-5 and 7-9. the Examiner has cited the Herve for reasons set forth in the Office Action on pages 3-4 of the Office Action, specifically mentioning that Herve teaching a first (melting) chamber surmounting a second (annealing) chamber. The Examiner continues, stating that the thermal conditions in each of the melting and annealing chambers are those which are necessary to obtain the expected effects of formation and growth of single crystals inside the crucibles. The Examiner continues, stating that Herve teaches that the temperature of the melting chamber is >1525 °C and that the temperature of the annealing chamber is <1525 °C. The Examiner goes on to state that while Herve does not teach a temperature difference of <50 °C as claimed by the present invention, a temperature difference of greater than 2 °C would have been obvious to a person of ordinary skill in the art since the temperature of the melting chamber can be 1526 °C and the temperature of the annealing chamber can be 1524 °C. The Examiner than states that it would have been obvious to a person of ordinary skill in the art to modify Herve by using a temperature difference of less than 50 °C because overlapping ranges are held to be obvious and changes in temperature are held to be obvious.

The Examiner admits that Herve does not teach annealing the crystal in the cooling zone by cooling the crystal from a first temperature to a final temperature at a substantially constant cooling rate of 3 °C/hour or less.

The Examiner cites Obara for teaching that after the temperature of the fluoride crystal has reached a temperature of 900 °C, it is possible to continue slow

cooling with "the same temperature decreasing rate", concluding that this reads on applicants' substantially constant cooling rate, and the temperature decreasing rate from 900 °C to 750 °C is set in the range of 0.1 to 5.0 °C/hr and the temperature decreasing rate from 750 °C down to completion is set in a range of 1.0 to 15 °C/hr.

Sakuma is cited for teaching the slower the cooling speed the greater the effect of the improvement on the optical properties and the cooling speed from a maximum temperature to room temperature is set to be 2 °C/hour or less. The Examiner concludes that Sakuma thus regards on applicants' substantially constant cooling rate.

Referring specifically to claim 3, the Examiner states that the combination of Herve and Sakuma or Herve and Obara teach 1020-1150 °C and 1200-1350 °C. concluding that overlapping rages are held to be obvious.

Referring to claim 7, the Examiner states that while the combination of Herve and Sakuma or Herve and Obara are silent regarding applying a decreasing fact cooling profile to the first zone and an increasingly slow cooling profile to the second zone, it would have been obvious to one or ordinary skill in the art at the time the invention was made to modify the combination of Herve and Sakuma or Herve and Obara by controlling cooling to obtain an annealing temperature after growth of the crystal as claimed because the first zone is at a higher temperature than the second zone. While this specific rejection is moot because claim 7 has been incorporated into claim 1, applicants will nonetheless comment on the rejection in the following section..

Applicants traverse all the foregoing rejections.

<u>Applicants' Traverse of the Rejection</u>

Claim 1, the only independent claim remaining in the application, has been amended by incorporating the language of claim 7. As a result claim 1 now further states that during cooling from the melt temperature to the first temperature a decreasing fast cooling profile is applied to the melting zone and an increasing slow profile is applied to the annealing zone.

Herve and Obara

First, with regard to Herve, applicants submit that in view of the above amendment to claim 1 the rejection of claim 1 is moot because Herve, either alone or in combination with Obara or Sakuma, does not teach or suggest maintaining a temperature difference of less than 50 °C between the melting and annealing zones, **and**, during cooling from the melt temperature to the first temperature, applying a decreasing fast cooling profile to the melting zone and an increasing slow profile to the annealing zone. When one applies the foregoing conditions together, one obtains a temperature profile, or crystal growth/annealing curve, as illustrated in Figure 2. This unique temperature profile provides a cooling/annealing regime than can consistently deliver an acceptable product result even with equipment and operation variability. For example, the crystal is more homogeneous and birefringence is minimized.

None of the art cited teaches or suggests the invention as not claimed in claim 1. Herve clearly does not teach a "less than 50 °C difference between the melting zone and the annealing/cooling zone. Herve also does not teach the convergence of the temperature curves for the two zones. Referring to Herve on page 13, lines 22-26, Herve teaches that the furnace has three chambers; namely, a melting chamber, an annealing chamber and a translation chamber. On line 23 Herve states that the temperature of the melting chamber is >1525. On lines 24-25 Herve states that the temperature of the annealing chamber is <1525 °C, *further defining the temperature as being 1200-1500* °C *in the top part and 200-300* °C *in the bottom part.* Applicants submit that it is clear from the Herve language that there is no temperature convergence in Herve and that there exists, at least at a distance away from the diaphragm separating melting and annealing chambers zone, a temperature difference that is much greater than any difference present according to applicants invention.

Second, with regard to Obara, while Obara may teach slow cooling at temperatures below 900 °C, Obara is actually silent on exactly what temperature

regime is used to grow a crystal. What Obara does mention is that the crucible is pulled down from the melting zone at a rate in the range of 0.1 to 5 mm/hr. Applicants refer the Examiner to Obara in column 10, lines 33-45 (see column 10, lines 39-45). The temperature of the melting zone is in the range 1420-1500 °C (see column 10, lines 33-36). There is no specific temperature mentioned in Obara regarding what is the temperature setting (or profile) for the zone into which the crucible is pulled (that is, a cooling zone) with subsequent growth of the crystal. The best conjecture one can make is that the unspecified temperature of this "cooling" zone is that it is in the range of 1200-1350 °C as indicated in column 10, lines 46-48 because Obara says that crystallization is complete at these temperatures. clearly these temperatures are outside the 50 °C limit set forth in applicants' claim 1.

The fact is that while Obara may mention slow cooling after 900 °C does read on the present invention because Obara does not mention what happens before this temperature. Specifically, Obara doe not indicate what it the temperature difference between his melting zone and his "cooling (applicants' annealing)" zone. Further, Obara does not teach or suggest that that it is advantageous to adjust the cooling rates of the melting zone and the "cooling (applicants' annealing)" zone such that they converge.

THEREFORE, in view of the foregoing facts and differences, applicants respectively submit that Herve or the combination of Herve and Obara does not teach or suggest applicants' invention as claimed in the amended claims for the reasons set forth above.

<u>**Herve and Sakuma**</u>

Applicants submit that the combination of Herve and Sakuma does not teach or suggest the claimed invention. Sakuma is cited for teach that the slower the cooling speed the greater the effect of the improvement on the optical properties. Sakuma is also cited for teaching a cooling rate that can be set at 2 °C/hour or less.

First, applicants submit that Herve does not teach or suggest the claimed invention for the reasons set forth above in the Section titles Herve and Obara" which is incorporated herein by reference.

Second, it should be made clear that Sakuma does not teach growing a metal fluoride crystal. What Sakuma does teach is annealing a crystal that was grown in a separate operation, placing the grown crystal in an annealing furnace, heating the crystal to a maximum temperature of 1150 °C and then cooling the crystal to produce an annealed crystal. Sakuma states that above a temperature of 1150 °C defects are easily generated in the crystal (see Paragraph [0053]). Sakuma is completely silent regarding taking a molted mass of metal fluoride material and growing a crystal. Consequently, Sakuma does not teach or suggest a *single step* procedure for growing and annealing a metal fluoride single crystal as is taught claimed by applicants.

Third, Sakuma's teaching regarding the use of a constant temperature is only with regard to annealing an already grown crystal. Sakuma does not teach how to make a crystal from a molten mass so that the stresses and birefringence (which can be caused by stress) are minimized during the conversion of the molted mass into a single crystal. Sakuma does not teach or suggest maintaining a temperature difference of 50 °C or less between a melting zone and an annealing zone. Sakuma does not teach adjusting the cooling profiles of the melting and annealing zones so that the two converge and become linear thereafter. In contrast to Herve, Sakuma, or the combination or Herve and Sakuma, applicants teach all of the foregoing.

THEREFORE, in view of the foregoing facts and differences, applicants respectively submit that Herve or the combination of Herve and Sakuma does not teach or suggest applicants' invention as claimed in the amended claims for the reasons set forth above. Applicants therefore submit that it is proper for the Examiner to withdraw this §103(a) rejection of claims 1-5 and 8-9 remaining in the application.

B. Rejection over Price in view of Obara or Sakuma

Claims 1 – 5 and 8 – 9 are rejected under 35 U.S.C.§ 103(a) as being unpatentable over Price (US 2002/0066402 A1) in view of Obara, et al (WO 02/0038625 A1, where US 6,850,371 is used as an accurate translation) or Sakuma, et al (US 2002/0038625 A1) for reasons stated in the Office Action. Applicants traverse the rejection.

First, Price does not teach or suggest the growing of a crystal while maintaining the temperature difference between the hot and cold zone to less than 50 °C. In addition, Price does not teach or suggest the use of a constant or linear cooling rate for a crystal from a first temperature to a final temperature.

Second, Sakuma likewise does not teach or suggest the use of a constant or linear cooling rate from a first temperature to a final temperature. Further, Sakuma does not teach growing a crystal from a melt while maintaining the temperature difference between the hot and cold zones to 50 °C or less. In fact, Sakuma does not even mention growing a crystal, but instead starts with crystal that is that has been grown in a previous process. Consequently, applicants submit that Sakuma does not, in combination with Price, teach or suggest the claimed invention which is directed to a one-step process for growing and annealing a crystal as taught by applicants' amended claims.

Third, with regard to Obara, while Obara may teach slow cooling at temperatures below 900 °C, Obara is actually silent on exactly what temperature regime is used to grow a crystal. What Obara does mention is that the crucible is pulled down from the melting zone at a rate in the range of 0.1 to 5 mm/hr. Applicants refer the Examiner to Obara in column 10, lines 33-45 (see column 10, lines 39-45). The temperature of the melting zone is in the range 1420-1500 °C (see column 10, lines 33-36). There is no specific temperature mentioned in Obara regarding what is the temperature setting (or profile) for the zone into which the crucible is pulled (that is, a cooling zone) with subsequent growth of the crystal. The best conjecture one can make is that the unspecified temperature of this "cooling"

zone is that it is in the range of 1200-1350 °C as indicated in column 10, lines 46-48 because Obara says that crystallization is complete at these temperatures. clearly these temperatures are outside the 50 °C limit set forth in applicants' claim 1.

The fact is that while Obara may mention slow cooling after 900 °C does read on the present invention because Obara does not mention what happens before this temperature. Specifically, Obara doe not indicate what it the temperature difference between his melting zone and his "cooling (applicants' annealing)" zone. Further, Obara does not teach or suggest that that it is advantageous to adjust the cooling rates of the melting zone and the "cooling (applicants' annealing)" zone such that they converge.

THEREFORE, in view of the foregoing facts and differences, applicants respectively submit that the combination of Price, Obara and Sakuma does not teach or suggest applicants' invention as claimed in the amended claims for the reasons set forth above. Applicants therefore submit that it is proper for the Examiner to withdraw this §103(a) rejection of claims 1-5 and 8-9 remaining in the application.

C. Rejection in View of Lo Iacono in view of Shiozawa, and further in view of Obara or Sakuma

Claims 1 – 5 and 8 – 9 are rejected under 35 U.S.C. 35 § 103(a) as being unpatentable over Lo Iacono (US 6,620,347) in view of Shiozawa (US 2001/0019453 A1) and further in view of Obara, et al (WO 02/077676 where US 6,850,371 is used as an accurate translation), or Sakuma, et al (US 2002/0038625 A1) for reasons stated in the Office Action. Applicants traverse the rejection.

Summary of the Rejections

Lo Iacono is cited for teaching a Bridgeman crystal growth method, a temperature gradient formed across a crucible by either lowering the crucible out of the hot side of a furnace to a cooler side, and also for teaching a temperature gradient between about 1-20 °C being formed in a two zone furnace. The Examiner

acknowledges that Lo Iacono does not teach a temperature difference of less than 50 °C.

Shiozawa is cited for teaching a vertical Bridgeman growth method using two heaters located above and below a solid-melt interface to control the temperature gradient at the solid-melt interface, for teaching that the temperature gradient can be determined to be 5 °C/cm is the temperature difference between the two heating element was 50 °C, and carrying our crystallization by a pulling down scheme from the high temperature zone to the low temperature zone.

Referring to claim 1, the Examiner states that the combination of Lo Iacono and Shiozawa teach temperature gradient to 1-20 °C/cm and a spacing of 10 cm, which requires a temperature difference of 10-200 °C. Overlapping ranges are held to be obvious. The Examiner acknowledges that the combination of Lo Iacono and Shiozawa does not teach annealing a crystal in a cooing zone by cooling the crystal from a first temperature to a final temperature at a substantially constant rate of 3 °C/hour or less.

Further referring to claim 1, Obara is cited for teaching that after the temperature of the crystal has reached 900 °C it is possible to continue slow cooling at the same temperature decreasing rate, the rates being 0.1 to 5 °C/hour in the range 900-750 °C, and 1-15 °C/hour from 750 °C to completion; and that it is possible to enhance the effect of preventing the development of cracks and deterioration of homogeneity in the refractive index as well. The Examiner holds that it would be obvious to modify the combination of Lo Iacono and Shiozawa by using the cooling rate of Obara to enhance the effect of preventing cracks and deterioration of homogeneity.

Additionally referring to claim 1, Sakuma s cited for teaching that the slower the cooling speed the greater the effect of the improvement of the optical properties and that the cooling speed is set at a maximum of 2 °C/hour or less. The Examiner holds that this reads on applicants' substantially constant cooling rate

Referring to claim 7 (now cancelled and incorporated into claim 1), while the rejection of claim 7 alone is considered moot because claim 7 has been incorporated

into claim 1, this rejection is traversed because it reads on amended claim 1. The Examiner acknowledges that none of Lo Iacono, Shiozawa, Obara or Sakuma, in the combination described in the Office Action, teach applicants' applying a decreasing fast cooling profile to the first zone and an increasingly slow profile to the second zone. However, the Examiner states that it would be obvious to one skilled in the art to use applicants' method because the first zone is at a higher temperature than the second zone.

Referring to claims 8 and 9, The Examiner acknowledges that the combination of Lo Iacono, Shiozawa and Obara, or the combination of Lo Iacono, Shiozawa and Sakuma are silent to the claimed optical properties for average homogeneity and birefringence. However, the Examiner states that these properties would be inherent in the fluoride crystal taught by the combination of Lo Iacono, Shiozawa and Obara, or the combination of Lo Iacono, Shiozawa and Sakuma.

Applicants traverse all the foregoing rejections.

__**Applicants' Traverse of the Rejections**__

Regarding claim 1, applicants refer the Examiner to Figure 2 in the application. Figure 2, and the Specification, teach that the temperature difference between applicants melting and annealing zones is held to be 50 °C, and that during cooling from the melt temperature to the first temperature a decreasing fast cooling profile is applied to the melting zone and an increasingly slow cooling profile is applied to the growth/annealing zone to diminish the temperature difference between the two zones. These criteria establish a short time for the convergence or near convergence of the melting and annealing zone temperatures. As a result of this convergence the formation of "defects", inhomogeneity and birefringence are minimized at a much early stage during than is accomplished by the cited art.

The *desirability* of reducing defects, inhomogeneity and birefringence in an optical fluoride crystal is well know because these traits impair the transmission of the electromagnetic radiation used for lithographic methods, which is the primary use of the optical fluorides of the present invention and the art cited by the Examiner.

Many ways of achieving this have bee proposed, including those of the cited art. The multiple cooling rate process in the growth furnace is unstable and sensitive to any disturbance, and the homogeneity and birefringence of crystals treated under the same process conditions vary widely with large standard deviations. Even if a desirable annealing profile can be identified for utilizing multiple cooling rates, it would be challenging to smoothly transition the multiple cooling rate cycles together without introducing any disturbance to the crystal. In addition, the optimal cooling profile/rate for a specific temperature segment can be different due to run-to-run and furnace-to-furnace variations, and it is very difficult to develop a universal process for all equipment configurations. In contrast with conventional multiple cooling rate approaches, the method suggested here pursues a linear or substantially constant cooling rate approach. A single cooling rate avoids rate change points that could have negative impact on the crystal. Furthermore, the simplicity of the linear or constant rate cooling profile promotes more stable furnace performance, permitting more consistent results from run to run. Since a substantially constant cooling rate approach treats every temperature regime equally, the temperature shift or fluctuation in the crystal due to the equipment and operation variations will not have as much impact on the crystal as the multiple-cooling rate approach. Applicants achieve this goal using a method as described in claim 1.

4. Double Patenting

Claims 1 – 5 and 7 – 9 are provisionally rejected under the judicially created doctrine of obvious-type double patenting as being unpatentable over claims 1 – 22 of the co-pending application number 10/652,013 in view of Shiozawa (US 2001/0019453 A1).

Applicant will provide a Terminal Disclaimer for the present application in the event that co-pending Application No. 10/652,013 is allowed and/or has issued prior to the allowance of the present application.

5. Conclusion

Based upon the above amendments, remarks, and papers of records, applicant believes the pending claims of the above-captioned application are in allowable form and patentable over the prior art of record. Applicant respectfully requests that a timely Notice of Allowance be issued in this case.

Applicant believes that no extension of time is necessary to make this Reply timely. Should applicant be in error, applicant respectfully requests that the Office grant such time extension pursuant to 37 C.F.R. § 1.136(a) as necessary to make this Reply timely, and hereby authorizes the Office to charge any necessary fee or surcharge with respect to said time extension to the deposit account of the undersigned firm of attorneys, Deposit Account 03-3325.

Please direct any questions or comments to Walter M. Douglas at 607-974-2431.

17 June 2005
Date

CERTIFICATE OF TRANSMISSION UNDER 37 C.F.R. § 1.8

I hereby certify that this paper and any papers referred to herein are being transmitted by facsimile to the U.S. Patent and Trademark Office at 703-872-9306 on:

17 June 2005
Date

Walter M. Douglas Date

Respectfully submitted,
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